now so large that our sense of proportion demands that attention should no longer be directed almost exclusively to the study of carbon compounds.

There is one other problem to which I would direct attention—the study of liquid diffusion. No interpretation of the remarkable results obtained by Graham has yet been given, and they appear in many cases to be quite at variance with the results of chemical inquiries. But there is a striking parallelism to be observed between Graham's results and those obtained on determining the electrical conductivity of solutions. Applying the view which I hold regarding the electrolysis of composite electrolytes to liquid diffusion, it appears to me not improbable that diffusion may be to a large extent the outcome not so much of the proper motion of the molecules of the dissolved substance as of a propulsive action exercised by the molecules of the solvent. The molecules in a mass of water we know may be assumed to be moving in every direction, and this being the case they would tend to carry other molecules along with them: the extent to which this action would take place would, however, largely depend on the attraction which exists between the molecules of water and those of the dissolved substance. From this point of view it appears of considerable importance to extend the study of liquid diffusion to dilute solutions. It may be added that this hypothesis would probably account for the behaviour of colloids, as these are known to be chemically neutral substances; in fact, they are compounds almost destitute of residual affinity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

KING'S COLLEGE, LONDON.—Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Electro-Magnetism, Magneto-Electricity, the Testing of Motors and Dynamos, Electric Lighting, and Transmission of Power, during the present Term. A course of practical work in Electrical Testing and Measurement with especial reference to Electrical Engineering will also be carried on under his direction in the Wheatstone Laboratory.

The lectures will be given once a week—on Mondays, at 2 p.m.,—and the Wheatstone Laboratory is open daily from 1 to 4, except on Saturdays.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 31.—"Note on the Development of Voltaic Electricity by Atmospheric Oxidation." By C. R. Alder Wright, D.Sc., F.R.S., Lecturer on Chemistry and Physics, and C. Thompson, F.C.S., Demonstrator of Chemistry, in St. Mary's Hospital Medical School.

Whilst investigating processes for the manufacture of cuprammonium hydroxide (now used commercially on a considerable scale) we noticed that if the air supply be greatly in deficiency relatively to the bulk of the copper, under certain conditions the solution is but little coloured, containing copper dissolved principally as cuprous, and not as cupric, oxide. This might, perhaps, be anticipated *a priori*, inasmuch as it is well known that blue cupric solution in ammonia, when digested with metallic copper in the absence of air, takes up a second equivalent of copper, becoming colourless cuprous solution; but further experiments seem to indicate that the production of cuprous oxide under the oxidising influence of a limited supply of air is the primary action, and not merely a secondary result.

When a sheet of copper is kept out of direct contact with air by being immersed in ammonia solution, oxidation of the metal is gradually effected by virtue of the dissolving of oxygen from the air at the surface of the fluid, and diffusion of the oxygen solution to the vicinity of the copper. This action is an extremely slow one if the copper be covered by some depth of fluid, and if the setting up of convection currents through heating or evaporation be prevented by keeping the vessel perfectly at rest and at an equable temperature, and well closed to prevent escape of ammonia; but if these precautions be neglected it goes on much more rapidly, and the liquid comparatively soon becomes blue; it can, however, be also materially accelerated by arranging horizontally on the surface of the fluid a plate of platinum or other electrically conducting material not chemically acted upon by the fluid, and connecting this by means of a wire, &c., with the copper plate. The upper conductor, or *aëration plate* as it may be conveniently termed, being simultaneously in contact with the atmosphere and fluid, attracts to its surface a film or aura of condensed gases, the oxygen of which becomes gradually transferred to the copper, a voltaic current circulating through the fluid and connecting wire. Cuprous, and not cupric, oxide thus results, dissolved in the ammonia solution in contact with the copper plate, the mechanism of the reaction being conveniently represented by the scheme—

$$\left\{\begin{array}{l}\text{Copper plate}\quad \mathrm{Cu_2}\mid \mathrm{OH_2}\mid \mathrm{OH_2}\mid \mathrm{O}\ \text{Aëration plate,}\\[1em] \text{Copper plate}\mid \mathrm{Cu_2O}\mid \mathrm{H_2O}\mid \mathrm{H_2O}\mid \text{Aëration plate,}\end{array}\right.$$

water being represented as the electrolyte for simplicity's sake. The air film on the aëration plate being constantly renewed by absorption from the atmosphere, the process goes on continuously as long as the two plates are connected together by the wire. This wire may be lengthened at will so as to make the current which passes through it whilst the action goes on relatively stronger or weaker according to the amount of resistance introduced into the circuit; and by including a galvanometer or silver voltameter in the circuit the ordinary phenomena due to the passage of currents are readily recognisable.

The maximum E.M.F. thus capable of development varies considerably with the strength of the ammoniacal solution, being the less the weaker the fluid; addition of common salt or of sal ammoniac to the liquid notably increases the E.M.F. and diminishes the internal resistance of the cell. Spongy platinum in a thin layer as the aëration plate gives higher values than thin platinum foil; the highest numbers thus obtained, using pretty concentrated ammoniacal brine, fell but little short of 0·8 volt; or somewhat less than the E.M.F. corresponding with the heat of formation of cuprous oxide,[1] since, according to Julius Thomsen, $\mathrm{Cu_2, O} = 40{,}810$ = about 0·88 volt.

It is obvious that this copper atmospheric oxidation cell has a close connexion with the "air-battery" described in 1873 by Gladstone and Tribe (Roy. Soc. Proc., vol. xxi. p. 247) in which what is virtually an "aëration plate," consisting of a tray full of crystals of silver is used, opposed to a copper plate immersed in a solution of copper nitrate. Cuprous oxide is formed in both cases, in virtue of the indirect combination brought about between the oxygen of the air and the copper: but there is this great difference between the two (apart from the cuprous oxide being deposited as such in Gladstone and Tribe's arrangement, and being kept in solution in ours), that in the one the cuprous oxide is formed *at the surface of the copper plate* itself, and in the other *at the surface of the aëration plate*. This essential difference is embodied in the above depicted scheme as compared with the following one which represents the action in Gladstone and Tribe's cell:—

$$\left\{\begin{array}{l}\text{Silver}+\mathrm{O}\ \left|\begin{array}{l}\mathrm{Cu(NO_3)_2}\\ \mathrm{Cu(NO_3)_2}\end{array}\right|\begin{array}{l}\mathrm{Cu(NO_3)_2}\\ \mathrm{Cu(NO_3)_2}\end{array}\left|\begin{array}{l}\mathrm{Cu}\\ \mathrm{Cu}\end{array}\right\}\ \text{Copper.}\\[1.5em] \text{Silver}\ \left|\ \mathrm{O}\begin{array}{l}\mathrm{Cu}\\ \mathrm{Cu}\end{array}\right|\begin{array}{l}\mathrm{(NO_3)_2Cu}\\ \mathrm{(NO_3)_2Cu}\end{array}\left|\begin{array}{l}\mathrm{(NO_3)_2Cu}\\ \mathrm{(NO_3)_2Cu}\end{array}\right|\ \text{Copper.}\end{array}\right.$$

One result of this difference is that the surface of the aëration plate in the ammonia cell is kept constantly the same, whereas in the nitrate cell it is continually changing its character through deposition of solid cuprous oxide on the silver: in consequence of this deposition, whilst the E.M.F. of the ammonia cell, *cæteris paribus*, is constant, that of the nitrate cell is continually varying. Gladstone and Tribe, moreover, only obtained an E.M.F. of $\frac{8}{83}$ to $\frac{11}{83}$ of a Daniell, or about 0·104 to 0·143 volt, even under the most favourable conditions, viz. when the cell was connected with an electrometer; whilst four or five times this amount is indicated by the cells examined by us.

Following up the ideas suggested by the above observations, we are making a number of experiments with a variety of analogous combinations, in which atmospheric oxidation constitutes the essential chemical action taking place; by varying the nature of the aëration plates, the metals dissolved, and the liquids employed (as also by substituting other gases, *e.g.* chlorine, for air), a large number of combinations are obviously obtainable. Some of those which we have so far examined present points of considerable interest, the oxidising action exerted under favourable conditions being strongly marked: so much so that certain metals, *e.g.* mercury and silver, not ordinarily prone to atmospheric oxidation, can under suitable conditions be gradually oxidised and dissolved in appropriate liquids, just as the copper is dissolved in the ammonia in the cell above described; these actions, moreover, being accompanied by the development of currents of strength sufficient to cause measurable amounts of electrolytic decomposition outside the cell, *e.g.* in a silver voltameter.

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[1] The actual chemical change going on in the cell is the synthesis of cuproso-ammonium hydroxide, so that the (unknown) heat of solution of cuprous oxide in ammonia should be added to this to obtain the total heat development.

"Action of Caffein and Theine upon Voluntary Muscle." By T. Lauder Brunton, M.D., F.R.S., and J. Theodore Cash, M.D.

Caffein and theine both cause rigor in the voluntary muscles of frogs (*Rana temporaria*). The action is, however, very variable, the rigor being sometimes exceedingly well marked, and at other times not observable. Theine seems to be rather more powerful than caffein, but the quantitative difference between them is slight. There is, however, a marked qualitative difference between them, inasmuch as theine tends to produce rhythmical contractions in the muscle. A variation is observed in the action of the alkaloids on the different muscles of the same frog.

The addition of lactic acid to a solution of theine or caffein causes the rigor to appear sooner, develop more rapidly, and attain a greater maximum, and a somewhat similar effect is produced by calcium chloride. Potash retards and diminishes the action of theine or caffein. One phenomenon which seems deserving of attention is the rhythmic contraction of the muscle produced by theine. This rhythm is so slow that it would escape attention unless a very low rate of speed were used in the recording apparatus; it is sometimes as slow as from three to about one contraction per hour; it may continue for twenty hours. In one instance we observed the remarkable phenomenon to which we have given the name of pseudo-rigor; in this experiment the application of the theine was followed by slight relaxation of the muscle, to this succeeded an equal contraction, and then followed great relaxation below the normal, so great indeed that the negative curve below the abscissa strongly resembled the positive curve of contraction due to rigor in most other experiments.[1]

"Contributions to our Knowledge of the Connexion between Chemical Constitution and Physiological Action. Preliminary Communication on the Action of certain Aromatic Bodies." By T. Lauder Brunton, M.D., F.R.S., and J. Theodore Cash, M.D.

The distinctive action of the lower members of the fatty series is their stimulant and anæsthetic action on the nerve-centres.

The members of the aromatic series also affect the nervous system, but they appear to affect the motor centres more than the sensory, so that instead of producing anæsthesia, like the members of the fatty series, they tend rather to produce tremor, convulsions, and paralysis. Benzene, chlorobenzene, bromobenzene, and iodobenzene are all somewhat similar in their action on frogs; the halogen radicals not modifying the action of the benzene to such an extent as they do in the case of ammonium salts. The voluntary muscles are weakened by them, and there is a slight tendency to paralysis of the motor nerves; but the action is chiefly exerted upon the brain and spinal cord. The brain is first affected, as shown by general lethargy and disinclination to move. Next the cord is affected; motions are imperfectly performed, and there is a tendency to general tremor on movement resembling that observed in disseminated sclerosis; sometimes, however, the tremor is observed independently of movement

The addition of hydroxyl to the benzene nucleus intensifies the convulsant action, so that oxybenzene (carbolic acid) and dioxybenzene cause convulsions in frogs, and trioxybenzene causes jerkings, though of a slighter character.

Zoological Society, April 5.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of March 1887.—Mr. F. Day exhibited and made remarks on a specimen of a Mediterranean fish (*Scorpæna scrofa*), taken by a trawler off Brixham early in March last, and new to the British fauna.—Mr. J. H. Leech exhibited some specimens of new butterflies from Japan and Corea, and gave a short account of his recent journeys to those countries in quest of Lepidoptera.—The Secretary read a letter addressed to him by the Rev. G. H. R Fisk, of the Cape Colony, respecting the killing and eating, by a shrew, of a young venomous snake (*Sepedon hæmachates*).—Prof. Flower, F.R.S., communicated, on behalf of Messrs. John H. Scott and T. Jeffery Parker, of the University of Otago, N.Z., a paper containing an account of a specimen of a young female *Ziphius*, which was cast ashore alive at Warrington, north of Dunedin, New Zealand, in November 1884.—Mr. Richard S. Wray read a paper on the morphology of the wings of birds, in which a description was given of a typical wing, and the main modifications which are found in other forms of wings were pointed out. One of the principal points adverted to was the absence, in nearly half the class of birds, of the fifth cubital remex, its coverts only being developed. The peculiar structure of the wings in the Ratitæ and the *Sphenisci* was also commented upon.—A communication was read from the Rev. H. S. Gorham, on the classification of the Coleoptera of the division Languriides. The author pointed out the characters which, in his opinion, were available for the systematic arrangement of this family of Coleoptera, and for its division into genera. The subject had hitherto not received the attention it deserved, and several errors had gained currency, owing to the hasty and insufficient way in which the structure of these insects had been analysed. He added an analytical table of about forty genera, many of those proposed being new. Further notice of the American genera would soon appear in Messrs. Godman and Salvin's "Biologia Centrali-Americana."

Mathematical Society, April 7.—Sir J. Cockle, F.R.S., President, in the chair.—The following papers were read, or taken as read:—On the intersections of a circle and a plane curve, by Prof. Genese.—A new theory of harmonic polygons, by the Rev. T. C. Simmons.—On some properties of simplicissima, with especial regard to the related spherical loci, by Mr. W. J. C. Sharp.—On Briot and Bouquet's theory of the differential equation $F\left(u, \frac{du}{dz}\right) = 0$, by Prof. Cayley, F.R.S.—Two points in the plane of a triangle and a cubic through them, by R. Tucker.—A tetrahedral note, by Dr. Wolstenholme.

EDINBURGH

Royal Society, April 4.—Dr. J. Murray, Vice-President, in the chair.—Prof. Tait communicated a note by Prof. Cayley, on a formula for $\Delta^n 0^i/n^i$, when n and i are very large numbers.—Mr. R. Kidston read the first part of a paper on the fossil flora of the Radstock series of the Somerset and Bristol coal-fields (Upper Coal-measures).—Dr. Sang read a paper on the achromatism of the four-lens eye-piece, describing a new arrangement of the lenses. He also read a note on an effective arrangement for observing the passage of the sun's image across the wires of a telescope.—Prof. Turner read a communication by Mr. F. E. Beddard, on the structural characteristics of certain new or little-known earthworms. Five new species found in Australia and New Zealand were treated of.—Prof. J. Geikie discussed the geology and petrology of St. Abb's Head.

PARIS

Academy of Sciences, April 12.—M. Janssen, President, in the chair.—On the relations that exist between cyclones and concurrent storms and hurricanes, by M. H. Faye. From an attentive study of the synoptical storm charts of the United States Signal Service, the author is able to confirm the conclusions already drawn by M. Marié-Davy from the meteorological observations made at the Paris Observatory so far back as the year 1864. It is shown (1) that tornadoes, hurricanes, and hailstorms are simply secondary phenomena directly associated with the central cyclonic movement; (2) that in the United States their trajectories have no general relation either to the isobars or to the normal atmospheric currents; (3) that these relatively short trajectories are parallel to the vast cyclonic trajectories at the moment when these local phenomena arise; (4) that they all lie on the right flank of the cyclone itself, which may thus be regarded as a complex meteorological system accompanied on its right side by whole colonies of destructive tornadoes and hurricanes with their attendant waterspouts, hailstorms, and torrential downpours, all moving together across seas and continents. The whole movement is regulated by the simple law of the mechanics of fluids, which determines the formation of spirals or vortices in the upper atmospheric regions. The surprising variety of the physical effects produced by the movement is simply due to the descending vortex, which, as in our electric machines, suffices to bring into contact and set in violent motion aërial masses lying far apart, with their consequent differences of temperature, and aqueous particles either frozen or in a state of vapour and of positive or negative tension.—On the term "latex" in botany, by M. A. Trécul. In reply to some recent objections made to his comprehensive use of this term, the author here justifies its application both to the contents of the laticiferous vessels and to the product of the secreting ducts. The numerous facts brought together in this communication tend clearly to establish the fundamental resemblance between the physical and physiological properties of the contents of the laticiferous vessels properly so called, and of the secreting tubes, so that these two classes of vessels are properly grouped together under the common designation of vessels of the latex.—On some essays made at sea with Capt. Fleuriais' new collimating gyroscope, by M. de Jonquières. The results are given of the observations made with this instrument by Lieut. Baule, of the steamer *La Gascogne*, during a recent trip from Bordeaux to Brazil. Although this was the first application of the apparatus, the observer was able by its means to record the rolling of the vessel with considerable accuracy.—On earthquakes, by M. Oppermann. The author substantially accepts the general view of seismologists, that these disturbances are mainly due to the pressure exercised on the upper crust by the aqueous vapour formed at great depths below the surface by filtration through fissures or porous rocks.—On the winter egg of Phylloxera, by M. P. de Lafitte. The author replies to some misleading statements recently made by M. Donnadieu, and calculated to affect the issue of the experiments which are now being carried on throughout the wine-growing districts of France.—On a complementary experiment relative to waterspouts, by M. Ch. Weyher. The experiments hitherto described had reference only to the artificial formation of the "*buisson*," that is, of the two inverted cones superimposed at their summits. Here a further process is described, by means of which the author has succeeded in producing the complete waterspout, with its tube of vapour attached on the one hand to the centre of the *buisson* and on the other to the centre of the revolving drum placed 3 metres above the surface of the water. To effect this all that is needed is to project a jet of vapour to the neighbourhood of the axis of the vortex, or, better still, simply to heat the water in the large reservoir sufficiently to cause some vapour to rise.—A study of the alkaline vanadates (continued), by M. A. Ditte. Here are treated the vanadates of soda: VO_5NaO ; $2VO_5NaO$; $3VO_5,2NaO$; $3VO_5NaO$; $VO_5,2NaO$; $VO_5,3NaO$; and VO_5NaO.—On the upheaval of the south-west coasts of Finland, by M. Venukoff. The topographic surveys recently carried out in Finland show once more that the shores of the Baltic are continually rising. Since the surveys of 1810-15 several islands have become peninsulas, while many shallows have become islands or beaches. On the south-west coast and in the neighbouring Aland Archipelago many places are pointed out by the inhabitants which a few years ago were under water, but which are now grazing-grounds, market-gardens, or cornfields. The local authorities are now taking steps, by means of which the progress of this geological phenomenon may in future be determined with absolute certainty and accuracy.—The sudden death was announced of M. Thollon in the midst of his labours connected with the construction of a great solar chart, on which the distinction between the telluric and solar rays would have been indicated. M. Thollon's name will always be remembered in connexion with spectroscopic studies, which have been greatly advanced by his improved spectroscope and by the device suggested by him for distinguishing rays of solar origin from those due to the terrestrial atmosphere.

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[1] This phenomenon is difficult to explain, but it suggests the possibility of a transverse as well as a longitudinal contraction in muscular fibre.—March 29, 1887.

BERLIN

Physical Society, April 1.—Prof. von Helmholtz in the chair.—Dr. Pernet spoke on the comparison of barometers, and drew attention to a number of sources of error which must be avoided when reading off a barometer. The speaker has carried out a series of comparisons with corrected standard barometers, aneroid barometers, and the standard barometers of different stations. He finds that the standard barometers of Berlin and Paris correspond exactly within the limits of errors of observation; aneroids do not yield anything like the same exactness that may be obtained with syphon-barometers.—Dr. Pernet also brought a new form of standard mercurial thermometer before the Society, and explained its construction. It consists essentially of the usual bulb and fine tube, which is widened out above and below into two receptacles each of which is capable of holding a mass of mercury corresponding to a column representing 50°. By means of this arrangement the instrument is easily graduated, and admits of any desired adjustment of the zero and graduation; also by varying the amount of mercury with which it is filled the same exactness in reading which is possible between 0° and 50° can be obtained even up to 200°.—Dr. Kötter spoke on the mean rate of flow of a fluid from a small aperture. This rate, as is well known, depends not only upon pressure, weight, &c., but upon a certain constant which is called the coefficient of efflux, and which has been determined to be 0·62. The speaker gave an account, in their historical order, of a number of researches which have been made with a view to determining this coefficient mathematically, and then proceeded to explain his own methods of calculation, which lead to the value $\frac{\pi}{2 + \pi}$ established by Kirchhoff and Rayleigh.—Dr. König exhibited a direct-vision spectroscope constructed by Wernicke, which is contained in a glass tube instead of a wooden one, and thus admits of the internal arrangement of the instrument being seen.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Journal of the College of Science, Imperial University, Japan, vol. i. Part 1 (Tokio).—Monthly Weather Report of the Meteorological Office, October 1886.—Beiblätter zu den Ann. der Physik und Chemie, 1887, No. 3 (Barth, Leipzig).—Journal of the Society of Telegraph-Engineers and Electricians, No. 65, vol. xvi. (Spon).—Journal of Anatomy and Physiology, April (Williams and Norgate).—Mind-Cure on a Material Basis: S. E. Titcomb (Trübner).—Annalen der k. k. Universitäts-Sternwartein Wien, iv. Band, Jahrgang 1884 (Williams and Norgate).—Quarterly Journal of Microscopical Science, March (Churchill).—The Auk, April (New York).—Journal of the Royal Microscopical Society, December 1886 and April 1887 (Williams and Norgate).—Bulletin of the American Geographical Society, vol. xix. No. 1, 1887 (New York).—Annalen der Physik und Chemie, 1887, No. 5 (Barth, Leipzig.)

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